Heat-Vulnerability Index for New York State

What is heat vulnerability?

Vulnerability to heat is how likely a person is to be injured or harmed during periods of hot weather. Heat vulnerability has been linked to individuals' characteristics (health status, age, race, income, language spoken, etc.) as well as certain aspects of the community where one lives (environment, community demographics). These characteristics or "heat vulnerability factors" can play an important role in one's ability to adapt to heat.

What is the Heat Vulnerability Index?

The effects of extreme heat on health can often be prevented. Heat-related deaths and illness are more common during the summer, especially in vulnerable populations. Since vulnerability and adaptability to extreme heat in New York State (NYS) is a growing concern, the New York State Department of Health (NYSDOH) created the Heat Vulnerability Index (HVI) to help local and state public health officials identify and map heat-vulnerable areas and populations in NYS (excluding New York City which has its own HVI). The HVI can assist in directing adaptation resources based on characteristics of vulnerable populations in that community and can inform long-term heat-mitigation planning efforts in the community.

The HVI can help local agencies make decisions to:

- set up cooling centers in rural and vulnerable areas where many do not have access to air-conditioning at home
- provide transportation to and from cooling centers in low income neighborhoods where there may not be public transportation or few people own vehicles
- include risk communication and alert messaging in multiple languages especially among communities with high proportions of people who do not understand English well
- arrange home visits of people in high risk groups like the elderly living alone

How was the HVI developed?

The HVI was developed to identify census tracts with populations that may have increased heat vulnerability. It is based on thirteen environmental and socio-demographic heat vulnerability factors that were identified from previous studies. Census tracts are subdivisions of counties and are defined by the US Census Bureau to collect, provide and present statistical data. Census tract level information for these heat vulnerability factors was obtained from the 2006-2010 and 2008-2012 US Census Bureau American Community Surveys (ACS) and 2011 National Land Cover Database (NLCD) for 2,723 census tracts in NYS (excluding New York City). Census tracts with zero population or missing census tract data were excluded. The 13 factors were grouped into four categories (Table 1) that represent different aspects of heat vulnerability, which in turn were used to estimate the overall HVI for each census tract. The four heat vulnerability categories include 1) language vulnerability; 2) socio-economic vulnerability; 3) environmental and urban vulnerability; and 4) elderly isolation and elderly vulnerability. The HVI (Figure 1) and four heat vulnerability categories (Figure 2, Figure 3,Figure 4, and Figure 5) were mapped to display populations in NYS that are most vulnerable to heat.

Table 1 US Census Bureau American Community Survey and National Land Cover Database variables in each Heat-Vulnerability Category

	Vulnerability Category	Heat Vulnerability Factors (Variables)
Heat Vulnerability	**Language Vulnerability**	Percent population that is Hispanic Percent population that is foreign born Percent population who speak English 'less than very well'
	Socio-economic Vulnerability	Percentage population with income below poverty level Percentage population that is Black Percentage population (18–64 years) that has a disability Percentage population (18–64 years) that are unemployed
	Environmental/Urban Vulnerability	Percentage houses built before 1980 Density of housing units per square mile Percentage land with highly developed areas Percentage land that consists of open undeveloped areas
	Elderly Isolation and Vulnerability	Percentage population 65 years of age and over Percentage population 65 years of age and over and living alone

How are the HVI scores calculated?

We used principal component analysis (PCA) with varimax rotation to reduce thirteen level heat-vulnerability variables to principal components. Four meaningful principal components were retained based on four criteria: 1) Eigenvalue-one or Kaiser criterion, 2) Scree test, 3) Proportion of variance, and 4) interpretability criterion. Scores of retained components were normalized (mean of 0 and a standard deviation 1) and were categorized into six groups based on the mean and standard deviations of the scores. Each category was assigned a score from 1 to 6 with a score of 1 indicating least vulnerable and 6 indicating the highest. The HVI was then created by summing the scores across the components for each census tract. The cumulative HVI was then mapped across the state.

Note: While residents of more heat-vulnerable tracts are at a higher risk of heat related illness, it is important to note that everyone is at some risk for heat related illness and low vulnerability does not mean there is no risk. Some populations within a tract can be more at risk than others, including older adults, children and those with pre-existing health conditions, and this risk can further increase if they do not use or have resources to cool down during an extreme heat event.

More Information on HVI:

- Heat Vulnerability Index: Statewide and County HVI maps can be found at https://www.health.ny.gov/environmental/weather/vulnerability_index/index.htm
- For more information on the HVI: Nayak SG et al. Development of the heat Vulnerability Index. Public Health 2017. Open access at https://www.sciencedirect.com/science/article/pii/S003335061730327X

Heat Vulnerability Index Data Dictionary

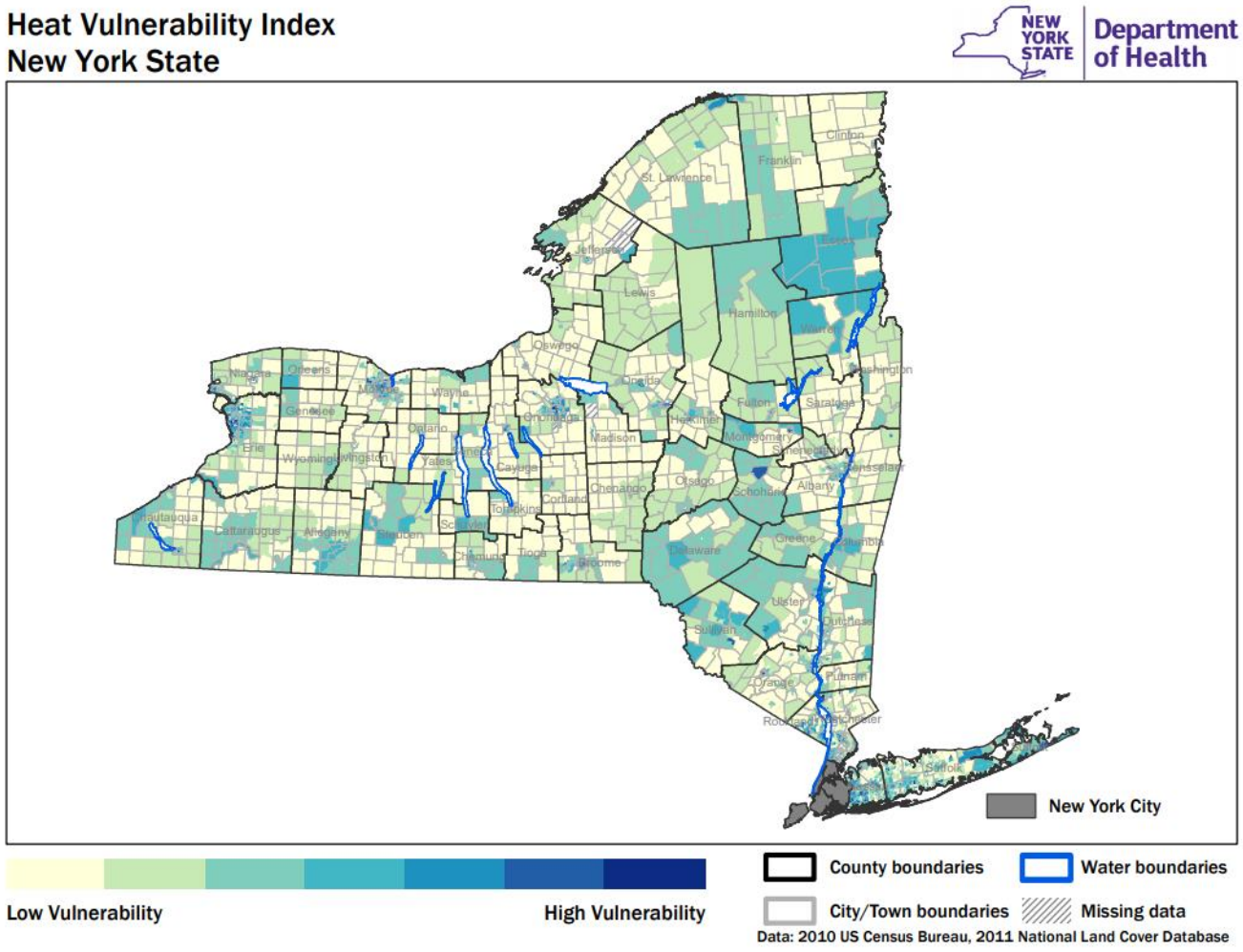
Variable	Description	Values	Data source
CensusTractID	Geographic identifier for census tract	11 characters	2010 US Census Bureau
StateFIPSCode	Federal Information Processing System code for the state	36=New York State	
CountyFIPSCode	Federal Information Processing System code for the state	36001-36123	
PercentHispanic	Percent population that is Hispanic	0-100	US Census Bureau 2006-2010 ACS*, table B03003
PercentForeign	Percent population that is foreign born	0-100	US Census Bureau 2006-2010 ACS*, table B05012
PercentNonEnglish	Percent population who speak English less than 'well'	0-100	US Census Bureau 2006-2010 ACS*, table B16001
PercentHomesPre1980	Percent houses built before 1980	0-100	US Census Bureau 2006-2010 ACS*, table B25034
PercentPoverty	Percent population with income below poverty level	0-100	US Census Bureau 2006-2010 ACS*, table B17001
PercentBlack	Percent population that is Black	0-100	US Census Bureau 2006-2010 ACS*, table B02001
DensityHousing	Density of housing units per square mile	>=0	US Census Bureau 2006-2010 ACS*, table B25001
PercentElderly	Percent population >65 years of age	0-100	US Census Bureau 2006-2010 ACS*, table B01001
PercentElderlyAlone	Percent population >65 years of age and living alone	0-100	US Census Bureau 2006-2010 ACS*, table B11007
PercentUnemployed	Percent population (18-64 years) unemployed	0-100	US Census Bureau 2006-2010 ACS*, table C18120
PercentDisability	Percent population (18-64 years) that has a disability	0-100	US Census Bureau 2006-2010 ACS*, tableC18120
PercentOpenUndeveloped	Percent land that consists of open undeveloped areas. Percent land rasters not in Class 21 (open developed land), 22, 23 or 24 (low, medium and high intensity development) †	0-100	National Land Cover Database†
PercentHighIntensity	Percent land with highly developed areas. Percent of land rasters in Class 24 (high intensity development) †	0-100	
LanguageScore	Language Vulnerability Component Score	1 =least vulnerable 6=most vulnerable	Created by NYSDOH
SocioEconomicScore	Socio-Economic Vulnerability Component Score	1 =least vulnerable 6=most vulnerable	
EnvironmentalUrbanScore	Environmental Urban Vulnerability Component Score	1 =least vulnerable 6=most vulnerable	
ElderlyScore	Elderly Isolation & Elderly Vulnerability Component Score	1 =least vulnerable 6=most vulnerable	
HVIScore	Cumulative Heat Vulnerability Score	1 =least vulnerable 6=most vulnerable	

*American Community Survey

†National Land Cover Database provides data in upon raster cells with 30m resolution. These data were aggregated to create census tract-based measures. Land rasters were identified as rasters not classified as 'Open Water' (Class 11).

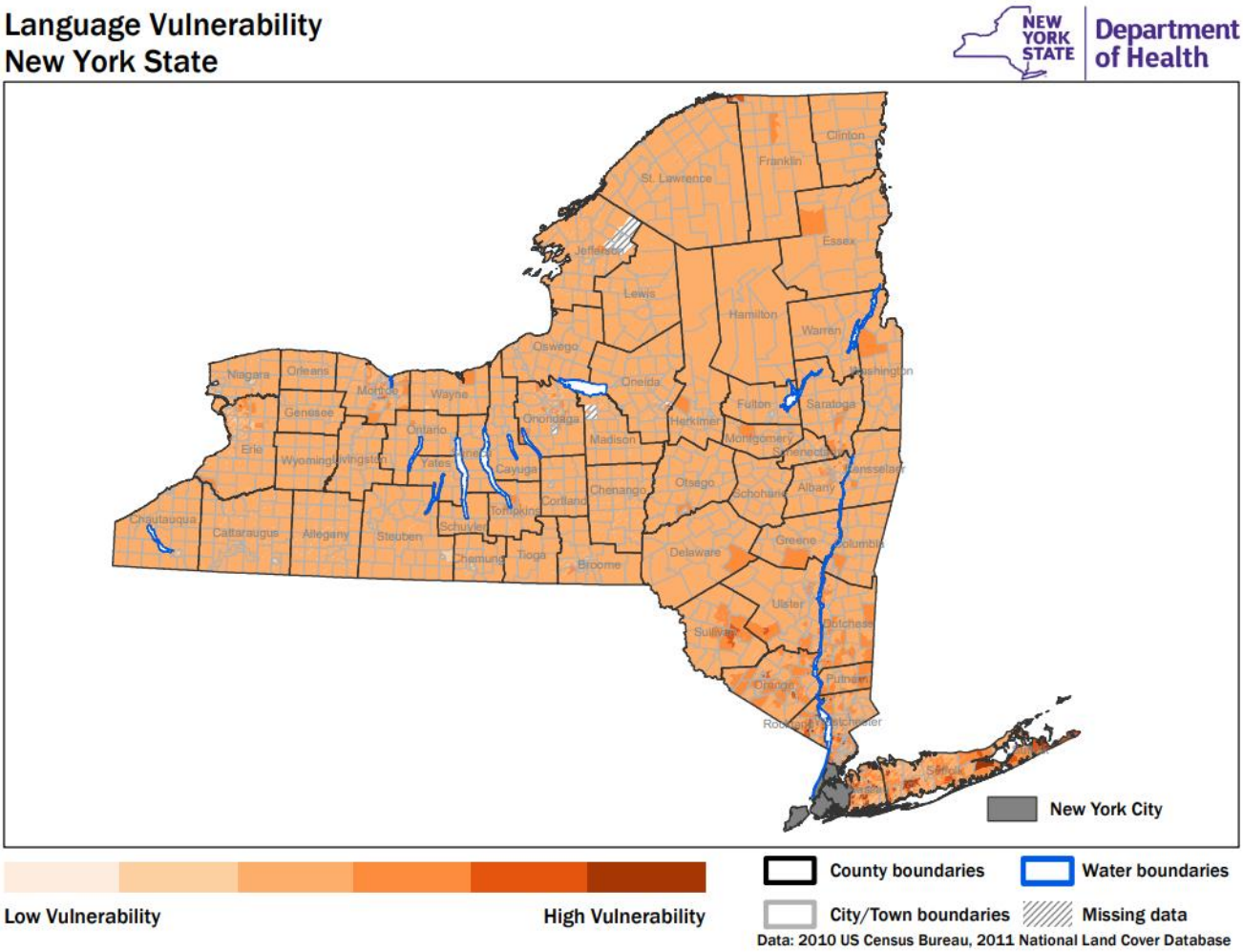
Maps of the NY State Heat Vulnerability Index and the four categories of heat vulnerability are displayed below

Figure 1 Heat Vulnerability Index for New York State



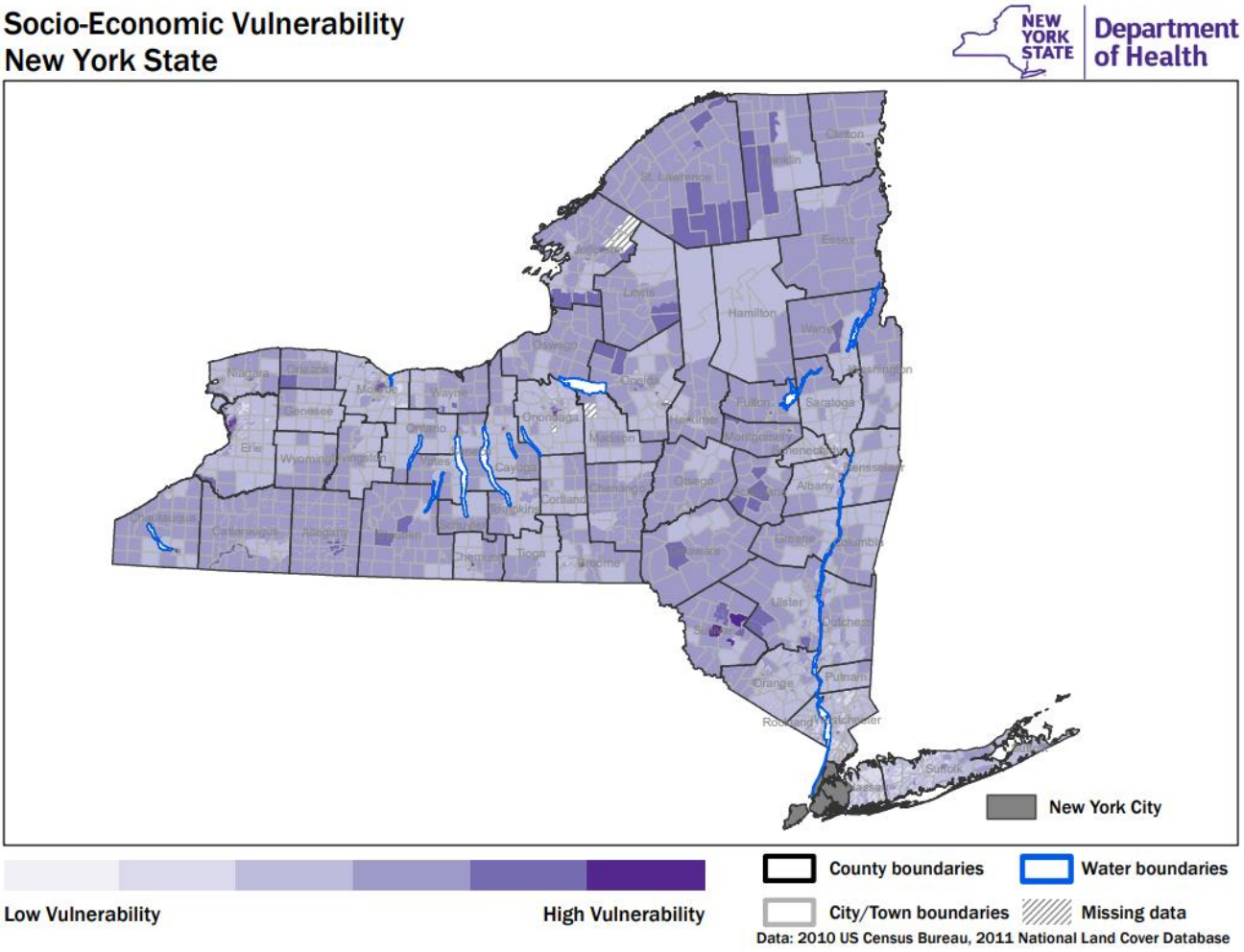
Overall, the Heat Vulnerability Index for NYS showed that metropolitan and inner cities are most heat vulnerable. More than a third of NYS population resides in areas identified as moderately to highly vulnerable to heat. In addition to identifying overall heat vulnerability, it is important to recognize specific vulnerabilities among population subgroups and take appropriate actions to reduce heat effects.

Figure 2 Language Vulnerability



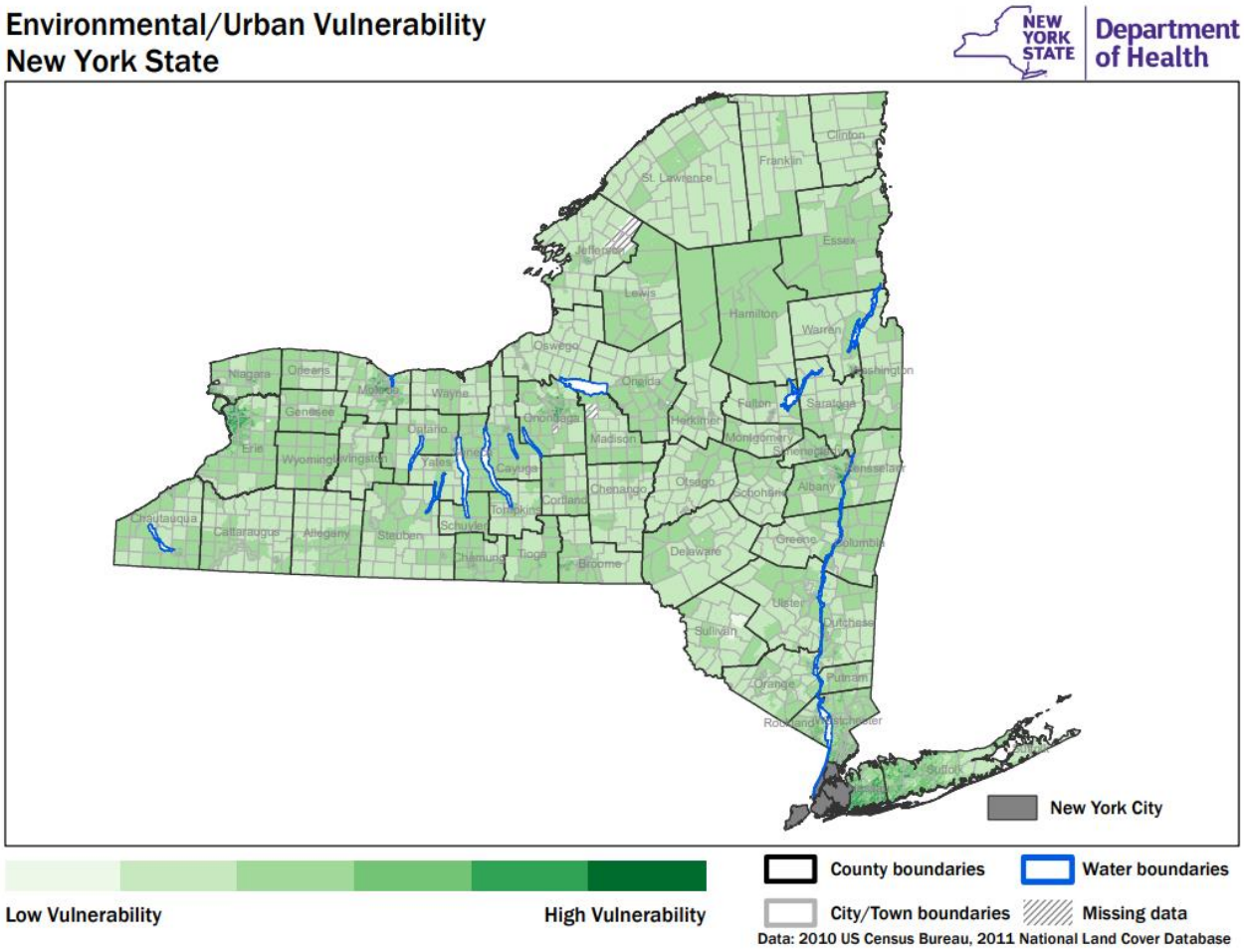
Downstate areas showed higher language vulnerability than upstate New York, reflecting the higher proportion of immigrants in these regions. Among immigrants and others with limited understanding of English, language is commonly a barrier to accessing resources and understanding alert messages issued during emergencies. Heat awareness messages should be announced in commonly spoken languages of the specific area in order to best communicate the risks of heat.

Figure 3. Socio-Economic Vulnerability



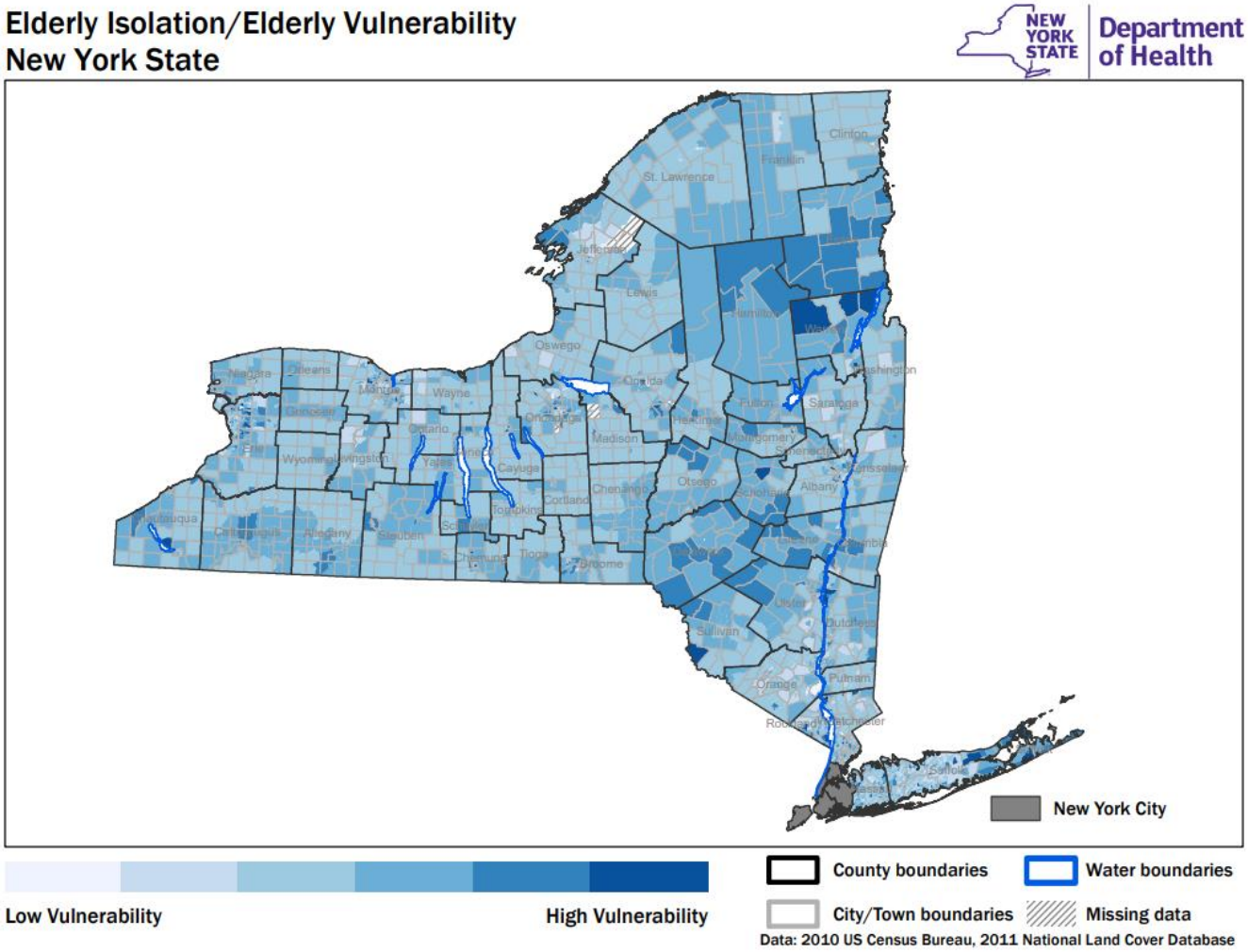
Vulnerability due to socio-economic status varied across the state with some clusters of vulnerable tracts in rural and inner-city areas. Economic status of both an individual and their community affect how one copes with extreme heat. While air conditioners use during hot days is highly recommended, this may not be an affordable option for low-income households. Community resources like cooling centers can help provide a few hours of relief from hot weather. Without public transportation getting to these facilities can be an obstacle for families and individuals who may not have their own vehicle.

Figure 4 Environmental Vulnerability



Vulnerability in urban areas is associated with the built environment where temperatures in areas covered by sealed surfaces are often considerably warmer than surfaces covered in vegetation. This is called the Urban Heat island (UHI) effect and is observed because materials used in buildings, roads and pavements tend to retain heat. Programs to reduce heat should include developing parks, increasing green space, constructing green roofs, and using other materials that help cool rooftops and pavements.

Figure 5 Elderly Isolation/Elderly Vulnerability



Vulnerability among the elderly was seen in rural areas of NYS where populations are often older than urban and suburban populations. Elderly people in rural areas may experience social isolation when they live away from family and the majority of the community. In addition, elderly in these areas will face the same challenges as other rural residents including fewer options for healthcare and thus less likely to receive timely assistance. For these reasons, efforts to reduce the health effects of heat should also target elderly in these areas.

Other Resources:

- County Heat and Health profile reports: summarize county temperature trends and heat-related health effects, identify areas with populations at highest vulnerability to heat, and list available adaptation resources in each county https://www.health.ny.gov/environmental/weather/profiles/
- Cooling Center information for NYS: https://www.health.ny.gov/environmental/weather/cooling/
- Explore heat stress related hospitalizations and emergency department visits in New York State: https://apps.health.ny.gov/statistics/environmental/public_health_tracking/tracker/index.html#/hsMonthandYear

For more information contact the New York State Department of Health, Environmental Public Health Tracking Program at epht@health.ny.gov